

# the Mechelectric



VOL. 12

APRIL 1953

NO. 5



**SCHOOL OF ENGINEERING  
THE GEORGE WASHINGTON UNIVERSITY**



## Tight reins in the stratosphere

FOR YEARS the performance of bombers and fighter planes at high altitudes has been seriously handicapped by "mushy" controls due to slackness in the cables.

That's because, when flying in the earth's upper atmosphere where it's sometimes as cold as minus 70°F., the aluminum airframe contracts much more than the carbon steel control cables. To take up the slack, all sorts of compensating devices were utilized. They were expensive. Were costly to maintain. They added cumbersome weight. Created potential lags in control response.

Now this problem has been solved. By the logical step of basically improving the control cable itself . . . by developing a steel cable that would contract and expand at practically the same rate as the plane's aluminum

frame. It took fifteen years to do it but it was worth the time and cost. We called this improved cable, HYCO-SPAN\*.

HYCO-SPAN Aircraft Cable, with a coefficient of expansion 50% higher than high carbon steel, and 33% higher than stainless steel, comes *closest* of any steel cable to matching the expansion and contraction of 24 ST aluminum alloy air frames.

Even without temperature compensating devices, HYCO-SPAN provides positive, responsive control that won't loosen or tighten up, that will remain free of lag and mushiness, and that prevents the development of plane flutter—no matter what the altitude, no matter how big the plane or at what speed the plane is flying.

In addition, HYCO-SPAN Cable, be-

ing non-magnetic, has no effect on sensitive airborne electronic equipment. Having the corrosion resistance of stainless steel, HYCO-SPAN stands up well in service in any climate. Its low coefficient of friction permits lower tension loads and improves stability.

HYCO-SPAN Cable is another example of the many interesting products developed and produced by United States Steel. If you're interested in becoming a part of a progressive organization after graduation, why not look into the opportunities with United States Steel? For more details, ask your placement director or write for the informative booklet, "Paths of Opportunity." United States Steel Corporation, Room 2810-S, 525 William Penn Place, Pittsburgh 30, Pa.

\*Short for "high coefficient of expansion."



3-696

UNITED STATES STEEL

# "True-or-False" Quiz on Business

Question	What Most People Believe	The Fact
How big are corporations' profits?	25% (or 25¢ out of each \$1 of sales).	7%. In most years actually <i>less</i> than 7 cents of each sales dollar.
Who gets the largest share of the income of corporations?	Most people say the owners do.	Actually the workers—they get 86%.
Does war increase corporation profits?	Many people think so.	The facts are—NO. Compared to a good peace year, corporation profits on the sales dollar went down from 6.4¢ to 4.3¢ in the last war.
Do machines put men out of work?	Most people say yes.	NO. In the automobile industry, for example, one man and a machine do the former work of 5 men, yet 20 times as many men are employed. Machines well used reduce costs and prices which broadens markets and so provides more jobs.
Do top executives make too much?	Too many workers think, "If their salaries were divided among workers, our wages could be much higher."	If <i>all</i> the salaries of the three top men in the country's biggest company were divided among that company's workers, it would take each worker in that company about three weeks to buy one pack of cigarettes with his increase.
Should taxes on corporations be increased?	"Yes," say many. "Soak the rich."	Truth is that high taxes already take so much money which should be spent in keeping machines modern, that 43% of America's machines are too old to protect tomorrow's jobs.

So much falsehood has been spread about business by communists that workers in their own interest should promote the truth. The best interest of workers, business and all the people is the same.

\* \* \*

*Warner & Swasey is a group of men who work hard, respect each other, and enjoy the satisfaction of group accomplishment. If that sort of life appeals to you, write Charles Ufford for employment opportunities here.*

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&  
SWASEY**  
Cleveland  
PRECISION  
MACHINERY  
SINCE 1860

## PLANNING THE RIGHT ANSWERS



*The complexity of modern air defense—extreme aircraft speeds, highly complex weapons, new combat strategies, the advanced state of today's technology—poses serious problems for the scientist and engineer.*



*One significant solution lies in the extensive use of airborne automatic equipment, including electronic digital computers, to augment or replace the human element in aircraft control.*

AT HUGHES Research and Development Laboratories each problem is attacked basically, beginning with systems planning and analysis. This consists of an exhaustive examination of the requirements of a problem, together with an evaluation of the best means for satisfying these requirements. The objective is to design the simplest possible mechanization

consistent with a superior performance.

These techniques, employing many special talents, are responsible at Hughes for the successful design, development and production of complexly interacting automatic systems for all phases of electronic control of interceptor navigation, flight control, and fire control. Similar accomplishments may be pointed to in the guided missile field.

Methods of systems planning and analysis responsible for achievements in the military area are also being applied at Hughes to adapt electronic digital computer techniques for business data processing and industrial controls.

*Dr. E. C. Nelson (left), Head of Computer Systems Department, and J. H. Irving, Head of Systems Planning and Analysis Department, discuss a problem in the systems planning and analysis stage.*

### PHYSICISTS AND ENGINEERS

*Hughes activities in the computer field are creating some new positions in the Systems Planning and Analysis Department. Experience in the design and application of electronic digital computers is desirable, but not essential. Analytically inclined physicists and engineers with a background in systems work are invited to apply.*

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## ON OUR COVER . . .

The City of Clearwater, Florida, more than doubled the storage capacity in its water distribution system by installing the 1,000,000-gallon ornamental standpipe shown. It is 43-ft. in diameter, 95-ft. to the high water line and 110-ft. high over all. A 24-in. diameter inlet pipe extends up through the center of the standpipe to a conical deaerator 20-ft. in diameter above the high water level. The outlet pipe is also 24-in. in diameter. A ladder providing access to the top of the standpipe is located in one of the six colonnades that extend up the shell and meet at a cupola in the center of the roof. This standpipe has increased the range of distribution pressures to from 20 to 47 lbs. per sq. in. Prior to the installation of the new standpipe, minimum pressures were as low as 10 lbs. and maximum pressures were seldom above 35 lbs. per sq. in. This standpipe was fabricated and erected by the Chicago Bridge & Iron Company. The plates used in its construction were pickled and painted by the Horton Phosphoric Acid Process.

—Cut Courtesy of Chicago Bridge & Iron Co.

## FRONTSPICE . . .

The Parabolic Pavilion was designed for a Livestock-Judging Pavilion for the North Carolina State Fair. The idea of the design of the two counteracting arches was that of Architect Mathew Nowicki. Nowicki was killed in an airplane accident before he could finish the plans so a friend of his, Wm. Henley Deitrick, also an Architect, carried on where Nowicki left off. He was assisted by the firm of Severud, Elstad and Krueger, Consulting Engineers. The roof is supported by catenary wires stretched from the concrete arches. This building was called a "Spectacular testimonial to Architect-Engineer Collaboration."

—Cut Courtesy of "Architectural Record"

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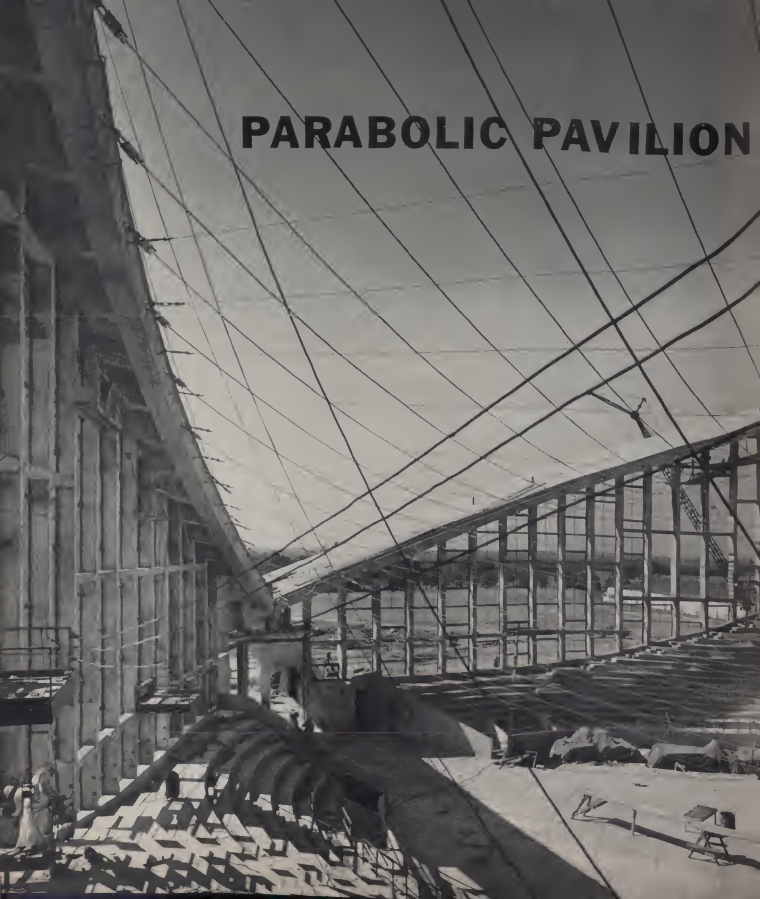
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# PARABOLIC PAVILION



## *A Society Comes of Age . . .*

*During this school year The George Washington University Student Chapter of the American Society of Civil Engineers has presented a program unmatched by previous administrations or other professional societies on this campus—or possibly on any campus. The high point to this date was the Prestressed Concrete Conference held the last day of January. This project alone overshadowed all previous attempts. The planning was carefully done and in ample time to allow for any unforeseen occurrences. Top men in the field were invited to present papers. An actual load test was arranged. A great quantity of publicity was circulated throughout the Eastern half of the United States. In short, all details were covered. The results of this careful planning were evident throughout the day as the different stages of the program came and went like clockwork.*

*The A.S.C.E. Student Chapter has, in addition to this Conference, carried out their expressed intention of presenting an interesting, informative and entertaining program at all of their monthly meetings. In order to insure this arrangements for speakers and/or movies at all meetings were made during the summer months and the complete program was presented at the opening of the Fall term.*

*It is through careful planning and such added attractions as conferences and field trips on a scale such as this that the undergraduate societies can truly justify their existence to all students. An example has been set this year which should show the way for the continued professional growth of the undergraduate societies of the School of Engineering.*

*Who will be the first to top this year's A.S.C.E. program?*

# *Sand and Submarines*

**by George R. Bierman**

*Undergraduate in Mechanical Engineering*

For untold thousands of centuries, the restless tides have washed sands onto thousands of miles of ocean beaches of the earth. Now man, in a Johnny-come-lately fashion, has but recently come to the end of a frenzied race to put the ancient sands to as modern a use as he knows—atomic power.

The sands from the beaches of Florida and Oregon became important as a source of zirconium; a metal lighter than steel, highly corrosion-resistant, having an extremely high melting point, and the fine structural qualities of being very strong and workable. For use in a nuclear reactor, however, its most important quality is that it does not "waste" neutrons.

It was for this quality of not "wasting" neutrons that zirconium was chosen as the structural metal in the Westinghouse submarine reactor, the power plant of the atomic submarine. Neutrons are the particles that split uranium atoms and keep the atomic engine operating. Some metals "absorb" these neutrons, thereby interfering with atomic fission. Zirconium offers no such interference and was therefore chosen in place of the more common metals such as steel, iron, and aluminum.

All the above-mentioned qualities together make zirconium second only to uranium in importance in building the engine for the atomic sub, and were the reason for the beginning of a scientific race for discovery which saw more progress made in the development of zirconium in the past three years than was made in the development of iron and steel during an entire generation.

The problem was far from solved when zirconium was found to be ideal for use in the atomic engine. At that time it was difficult to produce the pure metal and the cost was high—\$250 a pound.

The scientists and engineers of Westinghouse developed not only a process for producing pure zirconium in quantity, but also developed methods for using the less pure form of zirconium sponge, which now costs only \$15 a pound.

Most important, however, was the fact that they achieved quantity production of zirconium which was 99.9 per cent pure. It is this purity

with respect to certain elements that is the key to zirconium's resistance to corrosion and to the ductibility of the metal.

Considerable time was devoted to the problem of making zirconium corrosion-resistant, as well as cheap for use in the atomic power plant. Zirconium is a paradoxical metal—if handled properly, it is strong, stable, and corrosion-resistant; if improperly handled, it is brittle, unworkable, and corrodible. In some forms it is inflammable.

If chips from a piece of zirconium being machined become ignited, water will not put out the fire. The hot zirconium combines with the oxygen in the water and causes the zirconium to burn more vigorously; also, hydrogen is liberated which burns or may explode. The paradox here is that one of the reasons zirconium is used in the nuclear reactor is that it is highly resistant to water even at the high temperatures involved in the water-cooled reactor. One of the problems involved in the production of useful zirconium was, therefore, to minimize the fire hazard.

The zirconium production process began with the zirconium "sponge"—porous chunks of the metal similar in appearance to coke. The sponge, produced at Albany, Oregon, by the Bureau of Mines, is the result of a six-step reduction process that begins with the zirconium-bearing sands from the ocean beaches. The sponge, while relatively pure, still contains impurities which must be removed before the metal can be used in the submarine nuclear reactor.

Nothing was overlooked or left untried in the race to high-quality zirconium in volume. At one point, however, the scientists were momentarily stumped. The problem was this: to achieve a positive, air-tight seal for various large metal caps and valves which operated at very high temperatures and had to be removed frequently.

A good many important steps in the process were performed in large metal evacuated tanks. No ordinary gasket material that would stand up under extreme operating conditions could be used to seal off the caps and valves at the top of these tanks. The material finally selected for use as gaskets was pure gold.

*(Please turn to page 22)*

# *An Engineering Miracle* **THE GREAT PYRAMID**

**by Richard A. Haefs**  
*Undergraduate in Civil Engineering*

The record of engineering achievement is not limited to our modern age for there is ample evidence that even the ancient Egyptians possessed a great deal of engineering know-how. The best example of this is the so-called Great Pyramid, the Pyramid of Cheops at Gizeh, near Cairo. Even though their actual construction methods were somewhat primitive and they lacked the advantages of modern machinery, these Egyptians of five thousand years ago managed to erect to their king a monument that has lived down through the ages as one of the most colossal feats of engineering ever accomplished.

A study of the Egyptian pyramids quickly indicates that these ancients knew more of engineering and mathematics than we tend to give them credit. They evidently used many ideas and geometrical relationships in their construction that have been all but forgotten today and are even now being relearned. This fact is shown by the great precision of their measurements and by the lasting qualities of their work.

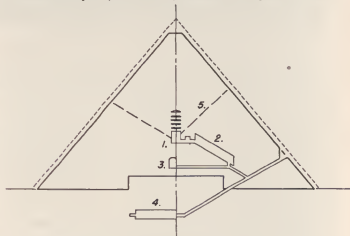
The Great Pyramid, as well as being the largest of them all, is also the most remarkable for its precision. The four sides are lined up in the cardinal directions, the error of azimuth being only 3 minutes 43 seconds. Remember that this was accomplished without any of the precise instruments that we have today. There is a mean error of only 0.6 inch in the lengths of the sides, and the base is only 12 seconds of angle from being a perfect square. The slope angles of each of the sides are as nearly equal as modern instruments can measure the rough form of the pyramid.

One of the most unusual features of the Pyramid of Cheops is that, as closely as can be measured, the ratio of the height to the perimeter of the base is as nearly as possible the same as the ratio of the radius to the circumference of a circle. Here, then, is man's closest solution to the age-old problem of "squaring the circle." Perhaps the Egyptians in their ancient civilization were in on some of the secrets of the universe that have since been forgotten somewhere along the line.

Even the location of the Great Pyramid is highly unusual. Could it be just coincidence that its axis is only a few seconds off of the 30th parallel? Because of its unusual properties there are those who place a great deal of spiritual and philosophical significance in the pyramid.

For one thing, the Pyramid ranks among the largest man-made structures on earth. Originally it stood 482 feet high and each side was 768 feet long. However, in the fourth century A.D. the outer casing was removed to provide building materials. This reduced the height to about 451 feet; the sides to about 750 feet. The monument is estimated to contain 85 million cu. ft. of stone; the base, to cover 13½ acres.

Structurally, the Pyramid of Khufus, as it is sometimes called, consists of 206 horizontal courses of hard, rough-hewn limestone blocks, averaging 26 inches by 58 inches, up to five feet high, and weighing an average of 2½ tons. The outside layers, however, consist of granite and



1. King's chamber, with five false ceilings to relieve pressure
2. Grand gallery
3. Queen's chamber
4. Subterranean sepulchral chamber
5. Air shaft

## Diagrammatic section through

### THE PYRAMID OF CHEOPS AT GIZEH

milk-white limestone blocks weighing up to 16 tons. The original outside casing was highly polished and well-jointed to present a smooth marble-like effect. The removal of this casing, however, exposed the rough, step-like terraces. Inside are four large chambers which evidently were intended to hold the remains of King Khufus and his queen. These galleries are connected by inclined passages. The arrangement of these

*(Please turn to page 22)*

# The Kelsh Plotter

by Dominick A. Bucci

*Undergraduate in Civil Engineering*

The Kelsh Plotter was developed in the late 1940's by Mr. Harry T. Kelsh. It consists primarily of five major component parts; a drawing table, a supporting frame, two projectors, a tracing stand and a voltage regulating device.

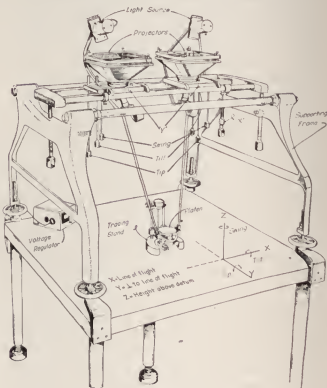
The drawing table is generally made of cast aluminum and is supported by five legs. The surface of this table must be accurately milled since the map will be compiled upon this plane. In addition to serving as the drawing surface, a metal framework resting on four adjustable foot-screws (one at each corner) is supported thereon. To this framework is attached a double track device which supports the projector frames. The track assembly is supported at one point at one end and at two points on the other. These three support points rest on adjustable screws by means of which the assembly can be oriented to any plane in space. The two projectors can be moved to any position along the track and locked in place.

The projectors, which are in reality miniature copies of the camera which took the original photograph, are suspended so that they may be rotated about each of the X, Y and Z coordinate axes. This rotational movement is performed by means of control knobs. In addition, the projectors can be moved along the X axis, and a limited amount along their Y axis.

The tracing stand is the device used for measuring in the reconstituted spatial model. This model is the three-dimensional image formed in the mind of the observer by combining the two projections stereoscopically. Primarily the tracing stand consists of a platen or circular reflecting screen on which the model is viewed, and a mechanism for measuring the vertical movement of the platen to within 0.1 mm. A small illuminated hole in the platen serves as the reference mark and enables us to make these measurements. A piece of lead held in a pencil holder is centered below the "floating mark," as it is known, so that when the mark is in contact with any feature of the stereo model (both horizontally and vertically) the lead will draw an orthogonal projection of that feature—constructed by dropping perpendiculars from the model to the drawing plane.

A voltage transforming and regulating device is necessary to furnish current to a light source above the projector body and to illuminate the

floating mark. In the Kelsh, only a portion of the model the size of the platen is illuminated at any one time. The light source is connected to the tracing stand and the light therefore follows any movement of the stand. Since the light is so concentrated, a small bulb of low wattage can be used and no blower is necessary for cooling.



KELSH PLOTTER

In operation, contact size positive transparencies of the original aerial negatives of two overlapping exposures are placed in the projectors and so oriented that the fiducial marks (index marks recorded on each exposure to define the principal point of the photograph) coincide with marks etched on the side of the carrier. This phase is called the interior orientation and in it the angular relationship that existed between film and camera lens is re-established between diapositive and projector lens.

In the second step, relative orientation, one projector is oriented to the other so that the two have the same angular relations in space that existed between the two camera stations at the time of exposure. This orientation is performed

*(Please turn to page 24)*

# It took 100 years of engineering

See that tiny speck of oxide on a hair-like wire? It's called a thermistor, and it's the first practical *thermally* sensitive resistor. It's so sensitive it will measure temperature variations within one-millionth of a degree. As a circuit element and control device, this small, stable and rugged unit has a place in a variety of electrical circuits.

Although the thermistor is the smallest and, in appearance, one of the simplest devices made by Western Electric—manufacturing unit of the Bell Telephone System—it was more than 100 years in the making.

Back in the 19th Century—some time before Western Electric was founded in 1869—Michael Faraday studied a curious thermally sensitive resistor material similar to that used in 20th Century thermistors. As Faraday and others after him discovered, the trouble with making effective use of this material was that different units made by what seemed to be the same process, showed large variations in their behavior. The problem of how to control the amount of impurities present in the material was finally solved a few years ago by our research team mates at Bell Telephone Laboratories.



At Western Electric's Allentown (Pa.) Plant hundreds of minute thermistor components are electrically tested and sorted every day. The basic component, an oxide, has a large negative temperature coefficient of resistivity.

## Western Electric



A UNIT OF THE BELL SYSTEM SINCE 1882



Once beyond the laboratory stage, Western Electric's engineers tackled the job of *mass-producing* the hard-to-handle oxides. After many trials they got a pilot line in operation—then a full scale production line through which compressed powders of thermistor material could be sintered into a strong, compact and homogenous mass. Today reliable thermistors are being made in many shapes and sizes—small beads, rods, discs, washers—to meet varying circuit and design problems. To make this possible, Western Electric engineers had to find new ways to apply a slurry of oxides on wire; new ways to extrude and mold oxide mixtures.

At every turn, the thermistor has presented fresh challenges to our engineers. Engineering is like that at Western Electric—where technical men of varied skills pool their knowledge in a constant search for new and better ways to do things.



The thermistor takes many forms depending on the resistance and power-handling capacity needed in a particular circuit.

### WANT TO KNOW MORE?

Send the coupon below for a copy of the 16-page technical monograph entitled, "Thermistors as Components Open Product Design Horizons."

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COLLEGE RELATIONS DEPARTMENT  
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I'd like more information about

- ☐ Thermistors and their application  
☐ Engineering opportunities at Western Electric

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## ENGINEERING PERSONALITIES

### DR. GREENSHIELDS



Dr. Bruce D. Greenshields, Professor of Civil Engineering at George Washington University, has played a dual role in the field of engineering — that of teaching and that of pioneering in traffic engineering.

The first important milestone in Dr. Greenshields' colorful career as an engineer was the securing of the degree of Bachelor of Science in Civil Engineering from Oklahoma University in 1920. He received the degree of Civil Engineer in 1927.

The next important step was his decision in 1928, while a Professor of Engineering Science at Denison University, to undertake graduate work in the field of Transportation at Michigan University.

A big factor in Dr. Greenshields' decision to delve deeper into highway engineering was his belief that the human element, that is the man behind the wheel, was not receiving sufficient attention in the science of highway design. It seemed to him that the characteristics of the automobile driver needed to be studied and analyzed as carefully as roadways and automobiles.

Dr. Greenshields spent the next four summers studying at the University of Michigan and then took sabbatical leave from Denison to complete his work. For his thesis, he selected the problem of highway capacity as the best possible topic. As highway capacity is a question of speed and spacing, Dr. Greenshields decided that the best approach to the problem was a succession of photographs taken at definite time intervals. This was the origin of the photographic method of traffic analysis, a valuable tool in modern traffic work. He received his M.S. from the University of Michigan in 1932 and his Ph.D. in 1934.

During the intervening years following the Ph.D. degree and his coming to G.W.U. as a Professor of Civil Engineering in 1946, Dr. Greenshields taught at City College of New York, New York University, and at Brooklyn Polytechnic Institute; conducted research work at the Bureau of Highway Traffic at Yale University; and handled extensive traffic studies during the summer months for the Ohio Highway Department.

Since coming to George Washington, he has continued to do work in the traffic engineering field as well as teach Civil Engineering. Along

*(Please turn to page 22)*

### MICHAEL BRANDIS RAPPORT



Michael Brandis Rapport came upon this earth July 28, 1922, down in Carolton, Alabama. At the age of 6 Mike, as he is known to everyone, started his formal education at Lakeview Grammar School in Birmingham, Alabama. From Lakeview he went to

Ramsey High School in the same city. Mike was a pretty busy young man in high school. Besides attending school, he jerked sodas for 36 hours a week and in 1939 won the Alabama State Tennis Championship and the Southeastern High School Conference Championship.

In November 1940, in the middle of his senior year, he joined the Marine Corps. At the age of 19 Mike had risen to the rank of staff sergeant. He was one of the youngest non-commissioned staff officers in the Marine Corps at that time. After almost 6 years in the Corps, five of them spent in the South Pacific, Mike met Miss Julie Dean Digby in Birmingham and in two weeks they were man and wife. Mike had to act fast to win Julie because she was engaged at the time.

Upon receiving his discharge from the service in December 1946, Mike headed for Washington, D. C., where Julie was waiting. His first job in civilian clothes was selling paint for the Sherwin-Williams Paint Co. After selling paint to anyone who would buy it, Mike, a born peddler, started work for the truck division of Studebaker as a salesman.

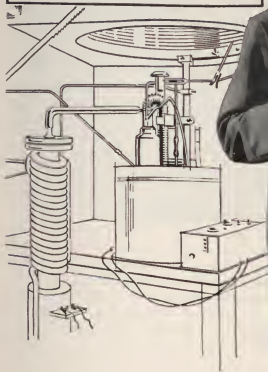
In 1948 Mike's interest in radio, which he had picked up in the Marine Corps, got the best of him and he started to Capitol Radio Engineering Institute here in Washington. After a year and a half at CREI, Mike decided that he wanted to be an engineer, not just a technician and he matriculated to George Washington University, from which he will graduate this spring.

In his three and one-half years at G.W., Mike has found time to participate in many extracurricular activities. He served on the staff of the MECHELECIV for one year before rising to the post of Associate Editor and then Editor. Mike served on the Engineers' Council for one year as delegate from the Institute of Radio Engineers and is past chairman of that society. Mike has also found time for social life in his time packed schedule. He was initiated into the Sigma Chi Fraternity last year. In the spring of 1952,

*(Please turn to page 22)*

## A MESSAGE TO COLLEGE ENGINEERING STUDENTS

from A. C. Monteith, Vice President  
in Charge of Engineering and Research,  
Westinghouse Electric Corporation



# There's room to grow at Westinghouse

It's natural that you sometimes wonder about the "elbow room" in the field of engineering. Even though the past half century has witnessed great technological developments, they are only a prelude to the things to come. We have barely scratched the surface in the fields of engineering development and research. And that, most certainly for you, should mean there is room to grow.

But first you must find the right starting point—a company which will give you the opportunity you want in your career. Westinghouse offers you this kind of

opportunity, for it is a growing company in a dynamic field. Energy is our business. Here at Westinghouse, well planned orientation and training, continued education, position rotation, and management development are all offered to provide you a favorable climate in which to grow.

To those who are prepared and willing—whether inclined toward research, engineering, manufacturing or sales—opportunities with Westinghouse are limitless.

G-10252

For information on career opportunities at Westinghouse, consult Placement Officer of your University, or, send for our 34-page book, *Finding Your Place in Industry*.

Write:

Mr. J. B. Parks  
District Educational Co-ordinator  
Westinghouse Electric Corporation  
3001 Walnut Street  
Philadelphia 4, Pennsylvania



**YOU CAN BE SURE...IF IT'S**  
**Westinghouse**

## ANNUAL ENGINEERING ALUMNI MEETING

Of tremendous importance to engineering students and alumni, the announcements made at the Annual Engineering Alumni Meeting set the pace for the near future.

At the meeting, held as a luncheon Saturday February 14th, Dr. Marvin announced that construction of the new Engineering Building, Tompkins Hall, would begin this spring. Dean Mason spoke after Dr. Marvin had announced that graduate engineering study would be initiated at George Washington this fall. The degree granted for successful completion of the graduate course of study will be Master of Science in Engineering.

Dean Elmer Louis Kayser as keynote speaker, spoke on the tremendous physical and cultural advancements the university has made in the years of its existence. Many alumni fondly recalled the first years of the University on "G" street, when the class rooms were in remodeled houses and when parking was readily available.

Dr. Marvin presented to the engineering students the recently remodeled Davis-Hodgkins House which will serve as a clubhouse and lounge for the students to relax, study and have office space in. In accepting the house on behalf of all engineering students and the Engineer's Council, Harry Kriemelmeyer, President of the Council, expressed appreciation over the fact that the University realizes that a college education is much deeper than classroom technical education, and that many advantages are to be derived from support of student organizations, and voiced hope that the new clubhouse would materially aid in reaching this goal.

Mr. Rube Leatherwood, Alumni Association Vice President presided over the meeting.

## MATERIALS HANDLING ROAD SHOW

A big-time industrial road show with fork-lift trucks as the actors is heading towards Washington on a 25,000 mile tour. The Yale & Towne Manufacturing Company has put a materials handling circus on a coast-to-coast tour. Features of the show include: a Big Top, the latest types of materials handling equipment, a truck that can actually "turn on a dime," an electric truck that only runs when the driver sits in the seat, movies, and light refreshments. The shows will be given three times a day and last 40 minutes each. This circus will be in Washington on April 23 and 24.

## ENGINEERS' CLUB MOVES

The Engineers Club of Washington has moved its quarters to the Washington Hotel. It previously was located in the National Theatre Building. The club, organized in 1947, is composed of engineers and architects of the District who are members of approximately 80 separate technical organizations here.

## BUFFET DINNER GIVEN BY MRS. MASON

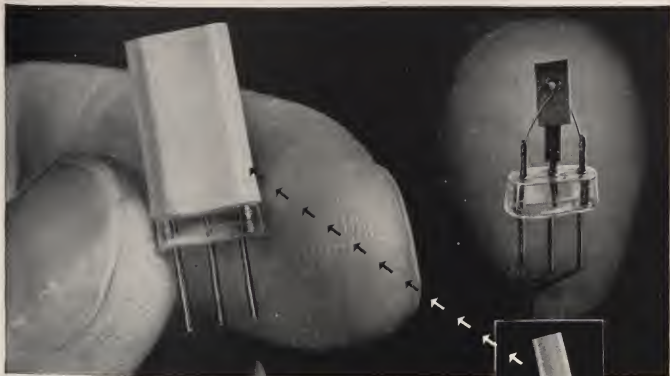
On Saturday March 28th, the Engineer's Council were guests at a buffet dinner at the home of Dean and Mrs. Martin A. Mason. A very enjoyable time was had by all. Everyone on the Council was raving about Mrs. Mason's delicious baked ham and baked beans.

## SCHOLARSHIPS OFFERED

The General Electric Company recently announced an expansion of its scholarship program to provide 100 grants of \$500 each for college juniors, an increase of 70 over the current number. These scholarships will be granted to outstanding college juniors to assist them to complete their senior years. Seventy of these scholarships will be for technical students and 30 for non-technical students. Selection will be made by the General Electric Professors' Conference Association. The association, representing more than 100 colleges and universities throughout the United States, is divided into 14 geographical divisions, each of which pass upon applications for the G-E technical scholarships and select the winners. Awarding these scholarships for the school year 1953-54, General Electric hopes to partially alleviate the national shortage of engineers. For further information contact Mr. G. E. Williamson, General Electric Company, Schenectady 5, New York.

Scholarships, fellowships and assistantships will be available to a number of graduate students studying in the Department of Food Technology at the Massachusetts Institute of Technology in 1953-54. Graduate students receiving financial assistance may work in any of these fields: food processing, bacteriology, food chemistry, flavor chemistry and food acceptance, effects of ionizing radiations and radio-activity on foods, nutritional biochemistry, radioactive mineral metabolism, food engineering applications, product development and research, and food packaging. Further information concerning these opportunities for

(Please turn to page 24)



Enlarged photo shows the transistor before and after being encased in its plastic shell. Inset, Transistor actual size.

# Transistor—

## mighty mite of electronics

Because of growing public interest in transistors, RCA—a pioneer in their development for practical use in electronics—answers some basic questions:

**Q: What is a transistor?**

**A:** The transistor consists of a small particle of the metal germanium imbedded in a plastic shell about the size of a kernel of corn. It controls electrons in solids in much the same way that the electron tube handles electrons in a vacuum. But transistors are not interchangeable with tubes in the sense that a tube can be removed from a radio or television set and a transistor substituted. New circuits and components are needed.

**Q: What is germanium?**

**A:** Germanium is a metal midway between gold and platinum in cost, but a penny or two will buy the amount needed for one transistor. Germanium is one of the basic elements found in coal and certain ores. When painstakingly prepared, it has unusual electrical characteristics which enable a transistor to detect, amplify and oscillate as does an electron tube.

**Q: What are the advantages of transistors?**

**A:** They have no heated filament, require no warm-up, and use little power. They are rugged, shock-resistant and unaffected by dampness. They have long life. These qualities offer great opportunities for the miniaturization, simplification, and refinement of many types of electronic equipment.

**Q: What is the present status of transistors?**

**A:** There are a number of types, most still in the development stage. RCA has demonstrated to 200 electronics firms—plus Armed Forces representatives—how transistors could be used in many different applications.

**Q: How widely will the transistor be used in the future?**

**A:** To indicate future applications, RCA scientists have demonstrated experimental transistorized amplifiers, phonographs, radio receivers (AM, FM, and automobile), tiny transmitters, and a number of television circuits. Because of its physical characteristics, the transistor qualifies superbly for use in lightweight, portable instruments.

*RCA scientists, research men and engineers, aided by increased laboratory facilities, have intensified their work in the field of transistors. New applications in both military and commercial fields are being studied. Already the transistor gives evidence that it will greatly extend the base of the electronics art into many new fields of science, commerce and industry. Such pioneering assures finer performance from any product or service trade-marked RCA and RCA Victor.*

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- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey. Also many opportunities for Mechanical and Chemical Engineers and Physicists.



**RADIO CORPORATION OF AMERICA**

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## SOCIETIES AND FRATERNITIES

### SIGMA TAU



• At the regular meeting of Sigma Tau on March 18, the students selected for membership in the Fraternity were introduced and pledged. They were R. T. Alexander, Richard F. Bargh, John E. Dodge, Festus B. James,

Bernard L. Kilday, Robert A. Klaase, Alfred O. Luning, Edward L. Malec, Raymond V. Nolan, James J. O'Connor, Joseph P. Pendergast, Robert T. Quick, George J. Rogers, Hunter L. Terrett, and William A. Yates.

Initiation of the new pledges will be held on the afternoon of April 18, and will be followed by a banquet and dance at the Continental Hotel.

Following the pledging ceremony, the Fraternity held elections of officers for the year 1953-54. The new officers are President, L. E. Goodnight; Vice President, A. B. Parks; Secretary, W. A. Guinan; Treasurer, R. P. Little; Corresponding Secretary, J. G. Heimens; Historian, G. C. Josephson, and Engineers' Council Representative, Herb Rosen. Professor Carl H. Walther was elected chapter advisor.

### ASME



• On March 4th, the student branch of the American Society of Mechanical Engineers heard Dr. Myles Robinson, Director of Research for the Air Transport Association of America discuss the problems confronting the airline

industry. Dr. Robinson covered all phases of air freight and passenger service. Seldom has the ASME had a speaker so full of his subject as Dr. Robinson and so eager to talk about it. Everyone benefitted from the lively discussion period which followed the talk.

### AIEE and IRE



• On Wednesday, March 4, 1953, the IRE and AIEE jointly viewed two motion pictures generously furnished by the General Electric Corp. These movies were entitled "Motors in Industry" and "Freedom and Power." They were thoroughly enjoyed by all.



The societies met again April 1st, and heard Mr. Ahrendt of the Ahrendt Instrument Co. speak on Servo-Mechanisms. Mr. Ahrendt's talk was interesting to both power and communications students. Everyone found Mr. Ahrendt's speech very interesting and especially enjoyed his method of presentation. Many of the students expressed a desire to have Mr. Ahrendt speak again in the near future.

At the business meeting following Mr. Ahrendt's talk a merger of the AIEE and IRE student chapters here at George Washington was discussed. The outcome of the

proposed merger will be related in the May issue of the MECHLECIV.

At a recent dinner given by the local branch of AIEE at White Oaks, Md., Homer Musselman, who was selected by members of the student branch as having done the most to promote the growth of the branch, was awarded a subscription to the magazine "Electrical Engineering."

### ASCE



• On March 4, Charles J. Stevens, past President of the District Chapter of the ASCE was guest speaker at the monthly meeting of the Student Chapter, ASCE, George Washington University. Mr. Stevens who is

Project Manager at the Bureau of Yards and Docks, U. S. Navy, spoke on "Ethics in Engineering."

According to Mr. Stevens, Ethics is the Science of Moral Duty. The principal ethic theories are Happiness, Perfectionism or Self-realism, and Stoicism.

The first six sections of The Code of Ethics of the American Society of Civil Engineers were adopted in 1918. The seventh section was added in 1934. The Code was completed in 1941.

In 1927, The Code of Practice which is a guide to the 'practical application of the Code of Ethics' was developed by a group of engineers from the Northeastern Section of this country. Daniel W. Meade made an extensive study on ethics in engineering. In 1939 he established a prize.

Mr. Stevens concluded by saying that through the development of the Society, engineers can continue to develop themselves.

### THETA TAU



• On March 21, 1953, Theta Tau initiated thirteen candidates into the fraternity, two of whom were honorary. Those students initiated were J. F. Andia, D. B. Boyce, W. A. Cornell, B. L. Kilday, Jr., Paul Kuzio, P. J. Martin,

C. F. Mohl, R. H. Van Sickler, G. W. Wagner, W. A. Weidmeyer, and R. C. Witham. Mr. Charles Hook Tompkins and Prof. Carl Hugo Walther were the honoraries inducted.

Mr. Tompkins, holder of a long and illustrious professional record as a General Contractor, has always been a staunch supporter of the Engineering School, as attested to by the new engineering building being named Tompkins Hall. His company has helped build and renovate almost every building on the campus.

Professor Carl Hugo Walther, instructor in Civil Engineering, has taken a keen interest in student activities, both with regard to the American Society of Civil Engineers and other engineering organizations on the campus.

On the 29th of March, Theta Tau elected its officers for the coming year. Regent Al Moe yielded the gavel to the incoming Regent, Tom Flanagan. Other new officers were: Bob Rodgers, Vice Regent; Phil Martin, Scribe; Paul Kuzio, Treasurer; and Bob van Sickler, Corresponding Secretary.

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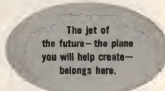
The P-38 Lightning—first 400 mile  
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# ALUMNEWS

Dr. Gordon M. Kline, M.S. Chem., 1926, recently received the Department of Commerce gold medal award for exceptional service. Secretary of Commerce Sinclair Weeks presented the award to him in a special ceremony at the Department of Commerce auditorium.

Dr. Kline joined the staff of the National Bureau of Standards in 1927 and pioneered in the research on resins which led to the organization of the organic plastics section under his direction in 1935. He was one of the first American scientists to investigate the German plastics and chemical industries before the end of World War II, and his activities resulted in a series of papers on specific developments in the German plastics industry.

Howard W. Hodgkins, B.S.C.E., 1913, L.L.B., 1916, has been with Wilkinson, Huxley, Byron & Hume, Chicago, Ill., since 1920 and a partner for over 25 years. Mr. Hodgkins had combat overseas service in both wars and is now retired as a Colonel, A.U.S. During the last war he commanded anti-aircraft groups in Africa and Italy. Alumnews is very happy to hear from you. Your letter and subscription have given us a lift.

Kenneth L. Sherman, B.S.C.E., 1931, has been at the Navy Countermeasures Station, Florida, since 1947 and is now Scientific Director.

Frank M. Albert, B.S.C.E., 1926, is a Registered Professional Engineer in the District of Columbia.

Richard D. McConnel, B.S.C.E., 1950, of Alexandria, Virginia, has been hospitalized for the last 2½ years. He would appreciate hearing from any and all of his classmates.

Konstantinos Karayianis, B.C.E., 1951, a former MECHELECIV staff member, sends his best wishes to the MECHELECIV staff. Dino is now a Lieutenant in the U. S. Air Force. Thanks, Dino, for the three-year subscription.

Albert D. Tinkenberg, A.M. (Psych.), 1948, is now working for the American Gas Association in Cleveland, Ohio. He says "I'm glad to see the improvement in the MECHELECIV." Your change of address to 1676 Eddington Rd., Cleveland 18, Ohio, has been noted.

D. L. Dutton (Col., Ret., Regular Army), B.S.C.E., 1913, is a Civil Defense official in Newark, Delaware. He says "best of luck to you. I always take time off from my Civil Defense duties to read MECHELECIV and keep up with activities back at G.W.U." Your three-year subscription is appreciated very much.

Emmett G. DeAvies, III, a former Associate Editor of MECHELECIV was commissioned a Second Lieutenant in the United States Air Force on Monday, March 16, 1953 at the Foster Air Force Base, Victoria, Texas.

To: The **Mecheleciv** Magazine  
Student Union Annex  
The George Washington University  
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*(Editor's Note: Include information about yourself and pictures; also comments on the magazine.)*

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Another page for

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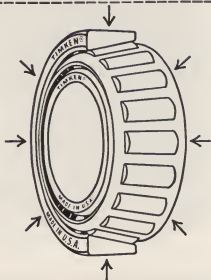


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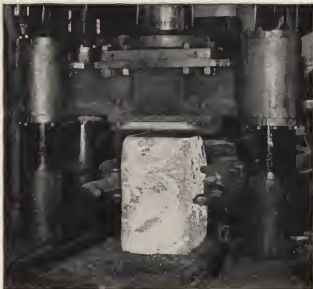
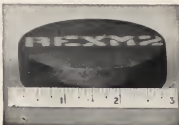
Crucible's reputation as the specialty steel leader is built on a devotion to the smallest detail . . . regardless of the size of the order.

These forgings are good examples of Crucible specialists at work:



**Rex M-2 High Speed Steel Disc Forging**  
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Pancake forgings such as these are used extensively by small tool makers. Extreme care is taken in the preparation of the slug stock. The upsetting insures proper flow lines. Milling cutters, gear shavers and similar cutting tools that require maximum toughness, coupled with the best cutting ability, are made from these forgings.



**CSM-2 Plastic  
Mold Forging**  
(14,000 pounds)



This CSM-2 plastic mold steel forging was made from a 25,000-pound ingot. This block will be heat-treated and worked to produce a mold for the manufacture of large plastic parts. The finished weight of the forging is 14,000 pounds. And it is the largest mold forging yet produced by Crucible.

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## SUBMARINES (Continued from page 8)

Pure gold was the cheapest satisfactory material to be found. It is soft enough to make a perfect seal and stands up well under conditions of heat and corrosion.

Gold, in the form of wire, proved to be cheap in this case, since it could be reprocessed after being used once and be drawn again into wire. Even though the first cost of \$35 an ounce was high, it was the ability to be used again and again that made gold practical. After this problem was solved, the production of zirconium was ready to proceed.

The zirconium sponge was loaded into a large tank, which also held a container of zirconium tetra-iodide, a combination of zirconium and iodine. The top cover of the tank, from which was suspended a series of four-foot-long U-shaped zirconium wire filaments, was then put into place. The tank was then heated in a salt bath and evacuated, and an electric current was passed through the zirconium wire, which started a chemical reaction.

The brick-red zirconium tetra-iodide vaporized and deposited pure zirconium on the hot wire filaments. The liberated iodine then moved back to the remaining sponge material and the cycle started again. The cycle was repeated until a considerable thickness of zirconium was deposited

on the wire. When the wire was finally removed from the tank, it was an irregular, hexagonal bar of super-pure zirconium that shines like silver.

The four-foot-long "crystal bars" were then rolled, cut up and melted into ingots, which were later forged and rolled.

Now, the value and safety of zirconium has been proven and the complicated processes for producing it are well-enough known that it is no longer necessary to have special laboratories and pilot plants to produce it. Also, it need not be carried to the super-pure "crystal bar" stage, since ways of using the cheaper zirconium sponge have been discovered. In the future the nuclear reactors will be built from the sponge, eliminating the need for the expensive crystal bar plant.

It is a tribute to the ingenuity of many hard working scientists and engineers that they have added a member to the great family of metals available to American Industry, a member wrested from the restless sands of sea and time.

## PYRAMIDS (Continued from page 9)

passages is said to preclude any possibility of a smaller pyramid having been started which grew into the huge structure we have today; therefore, the pyramid must have been planned from the beginning. This obviously would call for considerable engineering skill. The Egyptian engineers met the challenge.

When it is considered that this monument was built without any form of modern machinery it (Please turn to page 26)

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## DR. GREENSHIELDS (Cont. from p. 12) RAPPORT


with Dr. Weida of the Statistics Department, he co-authored a 238 page book on *Statistics with Application to Highway Traffic Analysis*. The work was sponsored by the Eno Foundation. Recently, Dr. Greenshields received through The George Washington University a grant of \$8000 from the National Science Foundation for the study of mathematical models of traffic behavior.

he was initiated into Sigma Tau, national engineering honorary. This past semester he received the honor of being tapped for Omicron Delta Kappa, national leadership honorary. In addition to all of this, Mike worked for one year as maintenance repairman on the digital and electronic computers at Stockton Hall.

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This Air Force Radio tower, a 1218-foot equilateral steel triangle, is the tallest in the world; second among man-made structures only to the Empire State Building. It was designed and fabricated by Republic's Truscon Steel Division. The operation of this tower is government business. But its stresses and its resistances are Republic's. The engineering of this lacy pinnacle will find adaptations in the near future. They are being shaped now in the metallurgy and design departments of Republic. A quarter mile above the earth, the steel toys with gales and totes an unpredictable burden of ice. And the facts of these achievements shall be translated by men of your generation into the still higher pinnacles of the future.

Republic's Truscon Steel Division leads the world in radio towers. Republic's other divisions push forward other frontiers. No manufacturer makes more kinds of steel, nor any better. But the making of steel is only one phase of Republic. Our many divisions design innumerable products, fabricate thousands of items.

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by using the rotational movements of both projectors in a trial and error method but following a prescribed procedure. When relative orientation is completed all of the Y-parallax has been removed from the stereo model. Y-parallax is the difference between the perpendicular distances of the two images of a point from the vertical plane containing the base line.

In the third step, absolute orientation, the model is related to pre-established ground control points, to horizontalize the model and bring it to a known scale. A minimum of two horizontal and three vertical control points are needed. Horizontalizing is performed roughly by means of three supporting screws on the track device and finally by using the four foot-screws on the supporting framework.

After the model is completely oriented the projectors are in exactly the same position with relation to the drawing table as the camera positions were with respect to a sea-level datum at the time exposures were made. The information contained therein is transferred orthographically to the drawing surface by means of the tracing stand. Cultural features are transferred by keeping the floating mark in contact with the feature both vertically and horizontally as the stand is moved along. Contours are drawn by setting the platen at calibrated intervals in the Z direction (using the measuring attachment) and again keeping the mark in contact with the spatial model as the stand is moved. The detail is then intensified or inked and the compilation is complete.

As in the Multiplex, stereo vision is made possible by use of complementary colored filters, (red and blue-green). One filter is placed in each of the light sources and a pair of filter spectacles is worn by the operator. In this way the left eye sees only the left projection and the right eye sees only the right projection. The mind then combines these images into the three dimensional model.

The Kelsh is very similar to the Multiplex in operation, but there are, as has been mentioned, some innovations in the Kelsh. Since contact size diapositives are used in the Kelsh, the compensation for distortion present in a Metrogon aerial camera lens, which in the Multiplex is accomplished by a compensating lens in a reduction printer, must be achieved in some other way. Actually the projection lens is moved up and down as the tracing stand moves away from the principal point. This up and down motion is controlled by a small ball-cam which has ground thereon a miniature distortion curve for the Metrogon lens. As the tracing stand moves, a small

follower rides on the curved steel ball and introduces the proper movement to the lens which is connected to a rod attached to the follower.

The model size in the Kelsh is about two times that for the Multiplex with the same photo and a pantograph attachment can be used to change this size in compilation. This large model size makes it a great deal easier to see differences in parallax and makes the orientation and overall accuracy in compilation almost twice that of the Multiplex. The Kelsh Plotter has a C-factor (ratio between flying height and the basic contour interval desired) of about 1000 as compared to 600 for Multiplex. The Kelsh is a relatively inexpensive piece of equipment (current price about \$6800), and this, combined with the facts that a reduction printer is unnecessary and the high order of accuracy possible, has made the Kelsh a very popular addition to the Photogrammetric mapping field.

# NEWS & VIEWS (Continued from page 14)

graduate study may be obtained from Doctor Bernard E. Proctor, Head of the Department of Food Technology, and application blanks are available from the Director of Admissions, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

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No industry matches aviation in offering young engineers such a wide range of experience, or such breadth of application—from pure research to production design, all going on at once. Boeing is constantly alert to new techniques

and materials, and approaches them without limitations. Extensive sub-contracting and major procurement programs—directed and controlled by engineers—afford varied experience and broad contacts with a cross-section of American industry.

Aircraft development is such an integral part of our national life that young graduates can enter it with full expectation of a rewarding, long-term career. Boeing, for instance, is now in its 36th year of operation, and today employs more engineers than at the peak of World War II.

Boeing engineering activity is concentrated at Seattle in the Pacific Northwest, and Wichita in the Midwest. These communities offer fine fishing,

hunting, golf, boating and other recreational facilities. Both are fresh modern cities with fine residential and shopping districts, and schools of higher learning where you can study for advanced degrees.

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# BOEING

# ENGINEERS' BANQUET

## MAY 2

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### PYRAMIDS (Continued from page 22)

becomes even more spectacular to the eye of the observer. The ancients used men and muscle, where we use machinery and power. Still, they did have all of the simple machines; the wheel, the lever, the pulley, the inclined plane, et cetera; and they used them extensively to increase the efficiency of their manpower. The story of the construction of the Great Pyramid under these conditions is fascinating indeed.

Herodotus gives us our best and most reliable account of this gigantic task. He describes the quarries at Masara where the huge blocks were hewn from the rock with bronze saws tipped with diamonds and corundum. Holes were made with tubular drilling tools much like our diamond drills.

Transporting these stones to the building site was a tremendous job in itself. The blocks, the largest of which weighed close to 60 tons, were rolled on a road of logs to the Nile where they were moved on to barges for the trip down the river. From the river the blocks were dragged to the site along a smooth, carefully-greased causeway. This causeway was 3051 feet long, 60 feet wide, and it took 10,000 men ten years to construct. Herodotus estimates that it took the same number of men another twenty years to actually build the pyramid.

It has often been asserted that the pyramids were built with slave labor. However, new evidence now indicates that these men were employed and were well cared for during their job, too. During the flood periods of the Nile the farmers were unable to work their fields, so it seems only natural that they should seek employment building the pyramids in order to support their families. Perhaps it was an ancient sort of WPA program.

In the past it was thought that the pyramids were built by dragging the stones up inclined platforms which were later removed. Now this idea has been discarded for the method described by Herodotus. He claimed that two machines, probably consisting of some sort of pulley arrangement, were used to lift each stone up one layer at a time. Teams of perhaps fifty men on a line provided the muscle to move these blocks. The smooth outer casing was started at the top, and the work progressed downward.

The intricate jointing, the precision, and the arrangement of the passageways, airshafts, and chambers, all testify to the skill of the architects. It was necessary for them to calculate the position of each key block as well as its relation to all the others. The permanency of their work is proof of their aptitude, and were it not for greed and the ravages of their enemies, the pyramids would be in just as good condition today as they were the day they were finished.

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## MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

*"What opportunities are available in General Electric for a career in manufacturing?"*

. . . EARLE E. WARNER, U. of Illinois, 1952

The answer to this question, presented at a student information meeting held in July, 1952 between G-E personnel and representative college students, is printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 123-2, General Electric Co., Schenectady, N. Y.



G. C. HOUSTON, *Manufacturing Services Division* . . . In General Electric manufacturing operations involve supervising and administering the activities of more than 100,000 men and women in more than 100 plants. This includes the operation of approximately 75 distinct product businesses, producing some 200,000 different products ranging

ing from heavy industrial equipment to precision instruments and consumers' goods.

The cost of manufacturing our products represents 70% of the total expenditure for all operations including research, engineering, marketing and other administrative functions.

With these activities and expenditures in the field of manufacturing one can readily visualize the breadth of opportunity in the area of manufacturing. This wide scope of manufacturing activities and the importance of their integration into an effective organization provide opportunity for challenging and rewarding careers in such areas as follows:

**Manufacturing Supervision:** The most important part of any manufacturing organization is men—those who apply their varied skills and talents to perform the many tasks involved in the manufacturing process. To direct the activities of these men, to inspire performance, co-operation and teamwork, to provide fair and equitable treatment, to see that work is done in required quantity—on time—and at the lowest possible cost, is the responsibility of Manufacturing Supervision. It offers a challenging and satisfying career for individual growth and development.

**Manufacturing Engineering:** This is the creative portion of modern manufacturing. It involves interpretation of initial product designs into good manufacturing practices through planning the methods by which a product will be manufactured, specifying and designing machine tools and equipment, and planning and developing new processes. It is vitally concerned with such subjects as plant layout, materials handling, operation planning, and quality control. It requires a thorough knowledge and broad understanding of how these subjects influence the manufacture of a product.

**Purchasing:** General Electric is one of the most diversified purchasers in the country today, buying material from every industry. Much of this purchasing involves technical problems, and requires a knowledge of sources of supply, market trends, and new products. Many items purchased are components or finished products of other technical industries. Constant contact with price, as well as evaluation of current and long-range raw material supply situations, is another phase of this activity. It is becoming more and more important as a career opportunity for young men.

In addition to the above described areas of opportunity in manufacturing, such manufacturing services as wage-rate determination, production control, inventory management, production planning and development, and materials handling offer opportunity for highly trained specialization and for competent management supervision.

These areas of manufacturing, together with many others, offer the college graduate of today a wealth of opportunity for a challenging and rewarding career.

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